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**The Effect of Multisensory Instruction on Semantic Knowledge of
Students with SLI**

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**The Effect of Multisensory Instruction on Semantic Knowledge of
Students with SLI**

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Report

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Abstract

The Effect of Multisensory Instruction on Semantic Knowledge of Students with SLI

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This research synthesis focuses on the effectiveness of multisensory approaches as a model for intervention for students with specific language disorders (SLI). The practices constituting the focus of this synthesis contain the following characteristics: (1) the intervention incorporates more than one sensory modality in method for teaching semantic skills and (2) the therapy targets semantic knowledge by increasing awareness of semantic features. Studies reviewed in this synthesis failed to control for possible threats to validity that could contribute to outcomes to the intervention. Furthermore, small sample sizes limited conclusions that can be made regarding the effectiveness of interventions. Therefore, there is not enough available research evidence to conclude that multisensory intervention is appropriate for targeting semantic skills for students with SLI.

Table of Contents

List of Tables	vii
Chapter 1 Introduction	1
Specific Language Impairment	1
Multisensory Approaches to Learning	2
Chapter 2 Search Strategy	4
Search Terms	4
Sources	4
Selection Criteria	4
Chapter 3 Search Results	5
Participants	6
Research Designs	7
Chapter 4 Intervention Characteristics	9
Therapy Tasks	9
Auditory	10
Visual and kinestheitic	12
Outcome Measures	14
Chapter 5 Results	16
Oral Semantic features	16
Written semantic features	17
Semantic Attribute Identification	19
Chapter 6 Limitations and Rival Explanations	21
Sample Size	21
Maturation Effects	21
Implementation	22
Chapter 7 Conclusion	24

References	26
Vita	29

List of Tables

Table 1: Characteristics of Research Participants.....	5
Table 2: Research Design and Intervention Variables.....	7
Table 3: Outcome Measures and Intensity.....	15

Introduction

The purpose of this research synthesis is to investigate the effectiveness of a multisensory approach to target semantic and lexical skills in elementary-aged students with specific language impairment (SLI). The conduct of this synthesis is guided by a framework developed by Dunst, Trivette, and Cutspec (2002) that focuses on similarities in the characteristics of intervention that produce the same or similar outcomes. The intervention constituting the focus of this research synthesis uses a multisensory approach specifically targeted at improving semantic knowledge of students with SLI.

SPECIFIC LANGUAGE IMPAIRMENT

It is reported that children with SLI often have smaller lexicons than their peers. Developmentally, these children often present with late onset of lexical acquisition (Watkins, Kelly, Harbers, and Hollis, 1995). Additionally, children with SLI have deficiencies in establishing word association maps when learning new vocabulary, leading to a smaller lexicon (Rice et al., 1994). School-age children with SLI must hear significantly more of the spoken word than their normally developing age-mates to recognize newly learned words, but not to recognize familiar words (Dollaghan, 1998).

As reported by a McGregor et al. (2002) when looking at the relationship between semantic representation and naming errors, most naming errors produced by children with SLI are associated with limited semantic representation. Receptive vocabulary tests often demonstrate a forced-choice format in which children with SLI may know enough words to score within normal limits (Dollaghan, 1987). However, as demonstrated by McGregor et al. (2002), children with SLI do not know these same words well enough to be able to retrieve them and use them correctly and consistently. The link between semantic knowledge and naming performance suggests that it is not the number of words that

children with SLI know that should be targeted, but rather the robustness of their semantic representations.

MULTISENSORY APPROACH TO LEARNING

Multisensory approaches to learning have been known to have overall benefits in learning due to the constant multisensory stimulation that the human brain undergoes and performs in effectively (Shams and Seitz, 2008). Multisensory refers to the use of two or more senses during instruction. According to Robles et al., 2003, it is necessary that as many sensations as possible be aroused to not only stimulate the brain, but to also assure retrieval of information. In the classroom, this is thought to be essential to reach the needs of as many students learning preferences as possible. Furthermore, research suggests that sensory based approaches to learning are optimal for children with profound communication and interaction difficulties and with multiple learning difficulties (Hewett and Nind, 1998). It is important to note that not all children with SLI experience multiple learning disabilities or severe communication difficulties, rather the abilities of children with SLI vary.

Vocabulary is learned through a process called fast mapping, in which semantic representations are attached to novel words. These semantic features are later fine-tuned and expanded upon with multiple exposures to the word (Perfetti, 2007). Semantic features are observed through multiple senses, therefore phonological, visual and auditory information are all attached to a novel word. The ability for a child to carry out this process effectively, results in not only an increased vocabulary but also in the ability to use words accurately and in multiple environments. In addition to fast mapping, memory also plays an important role in vocabulary retrieval. The brain processes auditory signals through a phonological loop, while visual information is processed through a visuospatial sketchpad.

The brain then coordinates auditory and visual information and transfers it from working memory to long term memory (Baddeley, 2003). In a study by Kibby et al (2004), researchers concluded that the presence or absence of a learning disability can impact the preference for visual, verbal and auditory information on working memory tasks. Therefore, some students may transfer information from working to long term memory given both auditory and visual information while others may prefer one to another. These findings suggest that students should be exposed to multisensory information in order to assure that it is meeting the needs of each individual's preference for optimal recall of semantic representations and word knowledge.

Given that research finds that children benefit from multisensory input, several vocabulary learning programs have been developed that explicitly use multisensory input. These are advertised to be highly beneficial to children because they provide multiple input modalities for children across the classroom to receive information in a way that can aid better comprehension of vocabulary knowledge. Features that characterize these programs are instruction in multiple sensory modalities and an emphasis on the understanding of semantic features. Some have been commercialized as the Expanding Expression Tool (EET; Smith, 2011) program or the Ten Steps to Becoming a Word Wizard program (Parsons et al., 2005). While there is research suggesting that multisensory information is important for learning, the extent to which such an approach is more helpful than other teaching approaches for children with SLI has not been evaluated. Therefore, in this research synthesis the purpose is to investigate the effectiveness of multisensory approaches for improving semantic knowledge of children with SLI.

Search Strategy

SEARCH TERMS

Identification of relevant studies was accomplished using the search terms: SLI and semantic intervention, vocabulary intervention for children with SLI, multisensory semantic intervention, multisensory learning, semantic skills in children with SLI, intervention/therapy for children with language disorders.

SOURCES

The above search terms were input into multiple research databases including, PubMed, MEDLINE Plus, Educational Resources Information Center (ERIC), Linguistics and Language Behavior Abstracts (LLBA). A search was also conducted on the search engine Google Scholar of search terms listed above. Finally, reference sections of articles identified were also searched for further relevant studies.

SELECTION CRITERIA

To be included in this synthesis, the studies had to meet the following criteria: (1) studies had to include elementary age students with SLI or a diagnosis of a language disorder, (2) a detailed intervention method had to be included, (3) the intervention had to include strategies that used at least two sensory modalities (4) the outcomes of the intervention had to be included. Case studies as well as studies that only included one student with an identified language disorder were also considered.

Search Results

Of the ten studies that the initial search yielded, three studies met the selection criteria. Two of the studies were review studies of multisensory intervention overall, looking at children with and without language impairment. In these studies it was not clear what outcomes were made by these two different groups. The other five studies did not provide a detailed intervention method; therefore, it could not be concluded that a multisensory approach was applied throughout the intervention period. Three studies were located that met the selection criteria (Dudek, 2014; Parsons et al., 2005; Munro et al., 2008). Several studies were excluded from the synthesis due to a lack of sufficient information regarding the method of intervention. Table 1 shows the characteristics of study participants and Table 2 shows the research design, intervention variables, and outcome measures.

Study	Number	Ages (years)	Grade Level	Gender	Diagnosis
Dudek (2014)	61	7;11 – 9;2	3 rd grade	36 females 25 males	4 diagnosed with language disorder
Parsons et al. (2005)	2	8;10 – 9;5	4 th grade	2 males	Specific language impairment
Munro et al. (2008)	17	4;8 – 6;5	7 in PreK, 7 in Kindergarten, 3 in 1 st grade	4 females 13 males	Specific language impairment

Table 1: Characteristics of Study Participants

PARTICIPANTS

Information regarding the characteristics of the children who participated in the studies was limited to age, gender, grade level and type of disability. A total of 80 children participated in the three studies. One of the studies (Dudek, 2014) also included information about the location of the students. Participants in this study were from a small rural community located in Central Illinois. All studies also reported that English was the primary language spoken by the students.

Gender across the studies was evenly spread out with 50% male and female students. Two of the studies (Dudek, 2014; Munro et al., 2008) recruited participants from local schools. The third study (Parsons et al., 2005) recruited students from waiting lists for community-based speech pathology services. Nationalities were only reported from two of the studies where participants were recruited from a greater region of Sydney, Australia and a school in Chicago, Illinois (Dudek, 2014; Munro et al., 2008).

Two of the studies recruited children with similar disabilities, specifically those with receptive and expressive language impairment that was later diagnosed as a SLI (Parsons et al., 2005; Munro et al., 2008). It is important to note that Dudek, 2014 recruited children with and without language disorders and studied the outcome of intervention across all children. Thus, the major purpose was not specifically to study those specifically with language disorders. This explains the small sample size ($N = 4$) of children with language disorders within the study, who were receiving speech and language services in the school under an Individualized Education Program (IEP).

Study	Research Design	Intervention Variables
Dudek (2014)	Pretest-posttest-posttest between groups design	Visual, auditory and kinesthetic interaction (EET)
Parsons et al. (2005)	Pretest/posttest within subjects design	Visual, auditory, and kinesthetic interaction
Munro et al. (2008)	Pretest/posttest within subjects design	Auditory and kinesthetic interaction

Table 2: Research Design and Intervention Variables

RESEARCH DESIGNS

As can be seen in Table 2, all studies employed a pretest/posttest design to assess semantic work knowledge before and after receiving multisensory intervention. One of the studies (Dudek et al., 2014) used a delayed posttest in order to measure generalization of the strategy used after completion of treatment to determine if students retained knowledge and skills developed. In this same study, there were two groups that receive the intervention at different intensities. One group received intervention twice per week while the other received it four times per week. Dudek et al., 2014 also used a control group to determine the extent to which the intervention impacted language skills to rule out maturation effects. None of the other studies included a control group. Two of the studies (Parsons et al., 2005; Munro et al., 2008) included a home program which encouraged parents to apply intervention strategies with parents. However, only one of the studies (Munro et al., 2008) reviewed the activities sent home in the following session. Furthermore, one of the studies (Dudek et al., 2014) used teacher and student acceptability ratings as a measure of social validity. Teachers and students in this study completed a ten item, 3-point Likert scale

survey measuring their perceptions of intervention acceptability and effectiveness during the first week of the intervention and within one week of conclusion of the intervention.

Intervention Characteristics

Two of the studies (Dudek, 2014; Parsons et al., 2005) implemented intervention within the regular school day. However, one of the studies (Dudek, 2014) implemented intervention within the classroom to all students while the other study (Parsons et al., 2005) pulled children from their regular classrooms to participate in intervention in a separate room within the school. One of the studies (Munro et al., 2008) did not report where intervention took place.

Intervention sessions ranged from 6 sessions to 36 sessions across all studies. As previously stated, Dudek, 2014 had two groups receiving intervention at different intensities ($T_1 = 2x$ per week; $T_2 = 4x$ per week), as well as a control group receiving regular curriculum vocabulary lessons. Intervention sessions across all studies averaged a total of 8 weeks. Munro et al., 2008 was the only study to only implement intervention once per week, but sessions lasted 60 minutes whereas the other studies (Dudek, 2014; Parsons et al., 2005) averaged 30 minutes per session.

THERAPY TASKS

As part of the selection criteria, therapy tasks had to be described in detail to be included in the research synthesis. This allowed to determine whether intervention strategies were truly multisensory and which senses were being used to target semantic knowledge. Due to the variety of different approaches to multisensory intervention targeting semantic representations found in the literature, it is not possible to directly compare each intervention. However, a common factor found across all studies is that they each targeted semantic knowledge by teaching it using auditory, visual and verbal interactions. Therefore, it is reasonable to compare how each intervention used these specific teaching modalities to enhance learning.

Auditory

For the purposes of this synthesis, auditory strategies are defined as those that adhere to an auditory learning style as defined by Gilakjani (2012). An auditory learning style processes information through listening and interpreting information by means of emphasis, pitch, and speed. Furthermore, auditory inclined students prefer to speak out loud and recite information learned and pick up on important information through speech and voice patterns (Gilakjani, 2012).

One of the studies (Dudek, 2014) implemented a multisensory, metalinguistic program designed to target knowledge of semantic features of words using a mnemonic device along with visual and kinesthetic cues to improve oral and written expression and comprehension. This program is the Expanding Expression Tool (EET; Smith, 2011) and is sold as a kit to be used in the classroom. Using the strategy, students describe a word by stating the following information: category (group to which an object belongs), function (what the item does, or what you can do with it), physical appearance (descriptions of color, size, and shape), composition (material of which an item is made, or the origin), parts/associated parts (parts of the object or objects associated or used with the item), or location (where an item is found or used). As part of the program, students are taught a chant to help them remember each semantic feature. In Dudek (2014), teachers led the students in the chant multiple times throughout the first few sessions. In large group lessons, the teacher would use the chant to guide students through describing familiar items as a class. After the first 5 weeks, however, this auditory cue was faded out as the students began to use the EET for essay writing and independent work. The auditory cue, the chant, was no longer used during lessons and activities during the eight week but teachers still encouraged students to hum it to themselves if needed.

Another study, (Parsons et al., 2005) implemented an intervention titled “Ten Steps to Becoming a Word Wizard.” Unlike the previous study (Dudek, 2014), this intervention did not include a chant or mnemonic device to brainstorm semantic features. Instead, this intervention (Parsons et al., 2005) used a type of auditory bombardment where the word was introduced to the student in many different contexts before the student and clinician began to define the word. After listening to the word being said multiple times, the student was asked if they knew what the word may mean. If they did not, then the word was repeated and a worksheet was completed where the student had to identify the initial sound of the word, think of a word that it rhymes with, and determine the number of syllables. Next, the student and clinician completed semantic information about the new word. This strategy aims to target phonological awareness before targeting semantic representations of a word. Although there is no evidence that targeting phonological awareness will increase semantic knowledge, it is evident that the combination of auditory bombardment and parsing of phonological information will assist in translating semantic information about new words into long term memory. This approach is consistent with findings that demonstrate that children with SLI need frequent exposures and formats to learn new vocabulary (Ukrainetz, 2006).

Another study (Munro et al., 2008) uses a similar approach to the previous intervention (Parsons et al., 2005). However, this study (Munro et al., 2008) implements scripted oral narratives adapted from a storybook series (Sound Starters, Sound Stories and Sound Rhymes; Love and Reilly, 1999) that use phonological awareness features, primarily rhyme and alliteration, to highlight embedded semantic features within the text. For example, a sentence within the story was written as follows: “Teddy brushed his teeth with a toothbrush and turned off the tap.” The clinician would then comment on the semantic information presented within the sentence by building semantic networks between the

alliterated words. In this example, the clinician would comment on the function of a word (toothbrush is used to clean teeth) and how other words within the sentence are associated through use, location, and/or prior knowledge (the tap provides water and is found in the bathroom). A major difference between this intervention and the two mentioned previously is that this study only targeted receptive semantic knowledge while the other two studies (Dudek, 2014; Parsons et al., 2005) targeted expressive semantic knowledge. The intervention strategy draws upon auditory cues of alliteration and rhyming to assist students in building semantic networks.

Visual and kinesthetic

Visual learning involves pictures and interpreting visual images. Information is recalled when presented visually where students can analyze visual patterns in color, shape, and direction. Kinesthetic learning deals with an active “hands-on” approach. This approach to learning takes advantage of the physical world to engage students and maintain focus for learning (Gilakjani, 2012). Visual and kinesthetic are grouped together in this section because of the way that the following studies used both strategies simultaneously.

Dudek (2014) implemented EET using the visual strategies outlined in the EET manual (Smith, 2011). The EET kit contains a string of beads (each representing a semantic feature previously described), visuals of each component to put on student desks, and stickers to be used for written activities. The variety of tools provided adheres to the visual learning style that some students may prefer. Throughout the intervention, all materials mentioned above were available during all classroom activities for the first eight weeks. During the ninth week of the intervention, the visual cues were removed during independent writing activities in order to encourage independence using EET in settings beyond the treatment sessions. However, students were shown one type of visual aid at the beginning of the lesson. Kinesthetic cues were implemented in a similar manner. Students

could manipulate materials given during activities, such as the string of beads and the stickers during essay writing. For example, some activities implemented allowed students to manipulate the stickers to better organize information when writing personal essay, to make writing flow. The use of visual and kinesthetic cues has been known to improve overall comprehension of new information or children with SLI (Ebbels and van der Lely, 2001).

After establishing the meaning and phonological information of new vocabulary, Parsons et al. (2005) had clinicians engage which children in a way that had them explore their environment looking for features that were synonymous of the new word learned. This activity required students to rely on visual and kinesthetic information to build more in depth definitions of words. For example, the word “corners” was a word targeted for some children. For this environmental interaction period, the child and clinician explored the classroom looking for edges and the point where they meet, giving them an example of what a corner was. The information learned from the interaction was then added to the initial worksheet to expand semantic knowledge. This approach is different from the previous study (Dudek, 2014), where rather than having a generic visual cue applicable across activities to learn new vocabulary, Parsons et al. (2005) uses the environment to help extract new information that they can see or feel in a less structured manner, aiding in retention of semantic features through encounter.

Munro et al. (2008) did not implement any direct visual strategies when teaching vocabulary. Although the storybooks were provided to give children a visual representation that highlighted semantic features, the books and pictured were not used to directly in the teaching strategy. Teaching semantic features primarily depended on the oral narrative. Munro et al. (2008) did implement kinesthetic strategies in the form of games after storybook reading to further reinforce semantic connections established. Games included

Snap and Odd One Out formats where students were required to state semantic features of words learned. The materials used for these activities were directly related to the semantic features targeted, therefore they could be manipulated to differentiate semantic features. These same games were sent home as follow-up activities. Research suggests that children with language impairments are more engaged in child-directed games than in interactive book reading (Kaderavek and Sulzby 1998), therefore Munro et al. (2008) implemented a combination of both to ensure that the intervention would be appropriate for children with SLI.

Overall, all studies used a multisensory approach when teaching semantic representations when teaching new vocabulary. Table 2 summarizes the research designs used as well as what sensory modalities were implemented in each research study. Although the interventions mentioned in this study are not identical, they are structured to provide students with SLI with diverse sensory information to aid word learning by drawing attention to semantic features.

OUTCOME MEASURES

All studies developed different methods to assess intervention outcomes, however, methods were compared and determined to assess similar semantic and vocabulary abilities. Outcome measures that were the focus in this synthesis included: oral semantic features (N = 2, 66%), written semantic features (N = 1, 33%), and semantic attribute identification (N = 2, 66%). Table 3 summarizes outcome measures used within each study as well as the intensity of intervention.

Study	Outcome Measures	Intervention Intensity
Dudek (2014)	<ul style="list-style-type: none"> • Peabody Picture Vocabulary Test – 4th Edition (PPVT-4) • Expressive Vocabulary Test – 2nd Edition (EVT-2) • Oral description of words • Written description of words 	9 weeks; 2x/4x per weeks; 20-25 minutes
Parsons et al. (2005)	<ul style="list-style-type: none"> • Word sort method task • Receptive semantic task • British Picture Vocabulary Scale (Dunn et al., 1982) • Test of Word Finding (German, 1989) 	18 sessions; 3x per week; 25-35 minutes
Munro et al. (2008)	<ul style="list-style-type: none"> • Word attribute identification task • Word association task • TTC • HPNT • Information and sentence length raw score from <i>The Bus Story</i> • PIPA • VMI 	6 weeks; 1x per week; 60 minutes

Table 3: Outcome Measures and Intensity

Results

ORAL SEMANTIC FEATURES

Dudek (2014) examined production of oral semantic features by looking at the total number of semantic features (TFO) and the different types of semantic features (TDFO) stated by students when asked to describe common nouns using the EET method. As previously mentioned, this study (Dudek, 2014) included children across three 3rd grade classrooms but four of these children were diagnosed with a language disorder. Results were analyzed separately for these children, however, there was no significant difference in outcome measures when compared to their peers.

Students with SLI were all part of treatment condition T₁, where students received EET intervention two times per week. This design limits comparison between treatment conditions specifically for children with SLI. Students with SLI as well as typically developing students improved oral language skills across all conditions. Therefore, no condition was more effective than another in improving student's ability to describe words using semantic features. Students with SLI showed similar improvement compared to other students in the same treatment condition. This finding is significant because of the knowledge that students with SLI have poorer semantic representations in comparison to their peers. It is suggested that while receiving EET intervention, students with SLI improved to have comparable expressive language abilities.

Although all conditions maintained oral language skills past the treatment period, the four students with SLI had lower scores compared to their scores during the treatment period. This suggests that students with SLI may benefit from longer and consistent intervention for long-term maintenance of oral language skills. Since all students with SLI received the same intensity of treatment, it cannot be determined whether receiving

intervention more than two times per week would increase retention of semantic representation abilities.

Munro et al. (2008) also looked at expressive oral semantic features during pre- and post-test tasks. The authors in this study employed a word association task where the student was asked to say any words that they thought of when they heard the target word. Although words did not have to be semantic features of the target word in order to be accepted, the authors analyzed how many of the children responded with semantic features as opposed to words that were phonetically or otherwise related. Overall, the number of responses increased between pre- and post-intervention. Specifically, the number of syntagmatic responses increased which included responses that provided a synonym/antonym, subordinates/superordinates and coordinates. These syntagmatic relationships are important because they include semantic features. This leads to believe that the intervention increased the students use of semantic features during the expressive task. However, an increase of other kinds of responses was also seen, therefore it is not possible to conclude that the intervention specifically targeted increase of semantic knowledge.

WRITTEN SEMANTIC FEATURES

In Dudek (2014), written oral expression of semantic features was measured by looking at the total number of semantic features written (TFW) and the total number of different semantic features written (TDFW). When comparing TFW measures from pre-test to post-test, all treatment conditions improved in the number of semantic features students used to describe words. This was also true for students with SLI. However, for the TDWF measure, there were two significant findings. First, post-test means of both treatment conditions significantly increased during the treatment period whereas the

control condition did not. This suggests that the intervention conditions were more effective than the control condition in improving semantic information in written form, leading to believe that although all conditions could orally use semantic features for describing, EET intervention greatly impacted the ability to apply this information when writing. Second, students with SLI also demonstrated significant improvement using the EET method to use semantic features while writing. It is known that students with SLI have poorer written skills than their peers due to poor spelling, syntax, and organization (De la Paz, 2001). Although these elements were not studied in these students writing samples, it is suggested that using EET methods, such as using stickers during writing, facilitated students with SLI in organizing their writing and provided a guide for using semantic features in their written descriptions.

When examining post-test scores and delayed post-test scores, there was no significant difference among scores in the Condition T_1 or the control group overall, suggesting that these students maintained their written semantic ability. However, the students that received intervention at a higher intensity (T_2) had increased TFW and TDFW scores. As for students with SLI, TFW scores remained the same at the time of the delayed post-test. However, TDFW scores slightly decreased at delayed post-test in comparison to their peers in the same treatment condition. This suggests that student with SLI maintained use of semantic features in their writing but were not able to provide a greater number of different types of semantic features post intervention. Although these differences were not significant, the results are comparable to results for oral semantic features. It appears that students with SLI may need longer treatment periods or more frequent exposure to strategies to maintain performance.

SEMANTIC ATTRIBUTE IDENTIFICATION

Two studies (Munro et al., 2008; Parsons et al., 2005) looked at semantic attribute identification to determine if improvement was made in identifying semantic features. Although each study employed their own methods for assessment of these skills, both tasks relied on receptive abilities and looked at identifying semantic features of nouns.

Munro et al. (2008) employed a method where 36 high-frequency nouns were tested. Half of these items had been trained on during intervention, while the other half were not and served as a measure of generalization to untrained words. During this task, students were presented with six pictures representing each noun and the examiner asked a question related to semantic knowledge. These questions related to each item's function, attributes, or an association. The student then pointed to the picture that answered each question. Mean performance improved post-intervention for both trained and untrained tasks. Significant change between pre-test and post-test scores for semantic features were present for semantic function and attribute components, but not for the semantic attribute component. In other words, students with SLI performed equally on questions relating to identifying semantic associations at pre-test and post-test. This suggests that implementing a multisensory approach using scripted storybooks to teach semantic features to children with SLI improved overall receptive semantic knowledge with the exception of identifying associations. It is possible that the concept of associations was too abstract for students with SLI, especially since it was not directly targeted as part of the intervention protocol.

Parsons et al. (2005) used a similar method for assessing semantic features post intervention, called the word sort method. During this task, five words were printed on separate cards and placed in front of the student. Two of these words were semantic features of the target word, one was a semantic distractor and one was a phonological distractor. The student was asked to choose the two words that best mean or were best related to the

target word. There were 18 treatment words targeted during intervention and 18 control words that were not targeted. A key difference between this method and that of Munro et al. (2008) is that children were presented with written words and not pictures, requiring students to read. Additionally, the words presented as answer choices were not target words. Overall, students made less errors post-intervention and none of the errors made were phonological or unrelated errors. Both students knew significantly more words after the intervention. However, semantic errors still occurred during post-treatment testing. One child even increased amount of semantic errors made in comparison to pre-test errors. Similarly to Munro et al. (2008), student with SLI made more errors on abstract words than concrete words, which would require them to make abstract associations when presented with an abstract word, a process that is more difficult for children with SLI. It appears that after intervention, students were more inclined to choose the semantic distractor response rather than the phonological distractor. This suggest that students with SLI gained semantic knowledge, however, they were prone to looking for the response that described a semantic feature but did not always choose the appropriate response. Reduction of phonological and unrelated errors suggests that students with SLI learned to deduce that words that sounded like the target word were not semantically related.

Limitations and Rival Explanations

There are multiple threats to internal and external validity for the reported outcomes present across all three studies.

SAMPLE SIZE

Due to the limited research on use of multisensory intervention to target semantic skills in children with SLI, the sample size for this synthesis was small. A major difficulty of this synthesis was that only a small number of studies provided detailed intervention methods that were necessary for determining that the intervention was truly multisensory and how it was implemented within each session. All of the studies gathered participants from a single geographic region, therefore results may not generalize to students from other regions and other schools. Two of the studies (Dudek, 2014; Parsons et al., 2005) each gathered participants from a single grade within a single school. Although SLI is one of the most common childhood learning disabilities, limiting the sample size by these parameters severely reduced the number of children with SLI accessible for each study (NIDCD, 2016). Parsons et al. (2005), had the largest sample size because it was not restricted by age. However, the author does not discuss how intervention outcomes varied across children, taking age and grade level into account. Additionally, due to limited sample size, it cannot be concluded that a multisensory approach would be successful in children who are not of elementary age.

MATURATION EFFECTS

Maturation effects are common in studies that look at the performance of students over time. In Dudek (2014), maturation effects could be seen due to the use of a control group. Although improvements in oral semantic features were seen in the control group as well as the intervention groups, the control group provided evidence that interventions

groups benefited from EET when it came to written semantic features which the control group did not make any significant gains. The other two studies (Munro et al., 2008; Parsons et al., 2005), used a one-group design which doesn't allow us to rule out the possibility that improvements could have been the result of maturation or other factors that occurred simultaneously with the intervention. Therefore, in those studies, it is possible that the use of a control group would have shown as similar improvements without the need of intervention.

Additionally, none of the studies specified whether participants were receiving speech and language therapy simultaneous to participation in the study. Because all children who participated were enrolled in school and had a diagnosis of SLI, it is possible that they were receiving therapy targeted at semantic knowledge concurrently and improvements were a result of the combination of therapies, intensity of treatment, or of school intervention. These variables could be avoided with the use of a control group.

IMPLEMENTATION

Implementation of intervention was different across all three studies. Although all three studies reported good measures of inter- and intrarater reliability, it should be noted that the primary person responsible for implementing the intervention varied. In Dudek (2014), the intervention was implemented by the classroom teacher after undergoing a period of training on EET. However, in two studies (Parsons et al. 2005; Munro et al., 2008), an SLP or a graduate student was the primary implementer, with a parent being responsible for using learned strategies at home. These differences in implementation matter due to the correlation of degree of experience as well as how well trained the implementer and the effectiveness of the intervention strategy. Across all studies, it was unclear whether the same individual consistently provided intervention in each session,

therefore it cannot be concluded that possible differences in implementation may have concluded to outcomes in each of the research studies.

Conclusion

This research synthesis focused on examining the effectiveness of multisensory intervention methods to target semantic knowledge of children with SLI. The multisensory approach to intervention has been accepted as an effective way to target a variety of students within a classroom because it acclimates to a multitude of learning preferences. Additionally, SLP's have begun to choose to use multisensory approaches with students with SLI because of their varied learning needs. Specifically, multisensory approaches have been created to target improvement of semantic skills to use in the classroom. These approaches have been discovered by SLP's and implemented with students with SLI due to the prevalence of children diagnosed with SLI in the schools and a shared weakness in semantic skills that accompanies this specific language disorder. Although overall improvement in semantic skills can be seen, there is not sufficient research evidence, as examined by the synthesis, that supports claims that multisensory approaches are effective in improving semantic skills in children with SLI or more effective when compared to other approaches. The main reason that this claim cannot be supported, is the lack of research available specifically looking at multisensory designs in comparison to other means of targeting semantic skills. Additionally, the lack of research available is partly due to the lack of methodology included in some research papers that claim to use a multisensory approach to target semantic skills. For the purpose of this synthesis, a detailed methodology section was needed to assure that the intervention implemented was truly multisensory and that it mainly targeted semantic skills as opposed to an overall language intervention program. Most of the studies in this synthesis lacked an experimental control, failing to effectively control for threats to validity or conflicting hypotheses. Furthermore, investigators in all studies failed to include formal assessments at pre- and post-testing which made it difficult to quantify progress made across studies and intervention periods.

Further study is needed to make conclusions about the efficacy of multisensory approaches for students with SLI, specifically when targeting semantic skills. Future researchers should use research designs that eliminate the possibility of an alternate hypothesis or don't allow for conclusions to be drawn about the quantity of improvement made. The research design should also include a control group, in an ethical manner, that will allow for comparison not only between intervention and lack thereof, but also between current methods being used to target similar skills. This will improve the efficacy of multisensory approaches for use as an intervention strategy better tailored to fit the needs of students with SLI.

Due to lack of research evidence conclusively attributing positive outcomes to multisensory intervention, clinicians should take caution when using these strategies with their caseload. Although semantic gains are possible, it is not fitting to believe that one approach will be successful in targeting semantic skills across all children with SLI or even across all children with a semantic deficit. In relation to SLP's, it is important to remember that ethically services and treatment approaches provided must not only prove to be effective, but should also be appropriate in relation to an individual student's needs (American Speech-Language-Hearing Association, 2000). Overall, multisensory approaches have been proven to be beneficial for classroom use, however, intervention programs modeled after the multisensory approach, specifically targeting semantic skills in children with SLI, need to be further researched to conclude to be efficacious.

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